SECTION 3: NONPOINT SOURCE POLLUTION CONTROL AND WATERBODY CHARACTERISTICS

Section 3 Contents

Understanding Management Measures and Practices

Management measures and practices are implemented at marinas primarily to control nonpoint source pollution, which in turn protects water resources and terrestrial and aquatic habitat, enhances the aesthetic appeal of the marina, and protects the marina and the people at it from toxic and harmful substances. The focus of this guidance is on management measures and practices that mitigate the generation of pollutants (using pollution prevention practices) and delivery of runoff, or nonpoint source pollutants (using source reduction practices) to our nation's coastal and fresh waters.

Management measures are defined under section 6217 of CZARA as

> economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint source control practices, technologies, processes, siting criteria, operating methods, and other alternatives.

Marinas and recreational boating management measures contain general management guidelines to prevent or minimize nonpoint source pollution. The states and territories in the coastal zone management program are required to implement these management measures through enforceable policies and mechanisms. The management measures and practices in this guidance are voluntary approaches in states not located within coastal zone boundaries.

Individual management practices are not included as part of the statement of the management measures, and states have considerable flexibility in determining *how* they will achieve the management measures.

Best management practices, or BMPs, are used to fulfill management measures. There are two basic types of management practices—pollution prevention and source reduction. Pollution prevention are those practices that are implemented to prevent the creation or release of pollution into the environment. An example is a vacuum sander that gathers sanding dust before it even has a chance to fall to the ground. Using a non-toxic cleanser in place of a toxic one is another example of pollution prevention. Source reduction controls are practices that are implemented to gather pollutants that have been released, but before they reach the water. They include practices that filter, screen, trap, contain, absorb, chemically neutralize, or divert pollutants before they reach a waterbody or ground water. An oil/water separator in a storm drain is an example. A tarp under a boat during hull maintenance, with follow-up disposal of all collected debris in a trash receptacle, is another example of source reduction.

Management measures and practices can also be either structural (e.g., used oil collection containers, multiple openings to a marina basin) or managerial (e.g., pollution control agreements in slip leases, marina policies regarding where boat hull maintenance can be done on the marina property and who is allowed to do it). Individual management practices are not usually sufficient for solving water quality problems, but are used in combination to control the diverse sources of potential pollution at marinas. For example, placement of absorbent pads in bilges is a good means to control the release of petroleum-based pollutants, but without storm water runoff controls in parking lots and air/fuel separators to control spillage during refueling, petroleum hydrocarbon pollution in the marina basin will be likely.

Management practices are best selected, designed, implemented, and maintained in accordance with site-specific considerations to ensure that the practices function together properly to achieve overall pollution management goals. For example, a grassed drainage swale designed to handle only the quantity of water expected to fall on a parking lot during a design storm will not effectively control pollution if the grassed drainage swale receives runoff from non-marina upland areas as well. When more than one management practice is used to control a type of pollutant from individual or multiple sources, the individual practices will work as a system more effectively if the design standards and specifications of the individual practices are compatible. Additional effectiveness may be achieved if BMPs for a site are selected within the context of an overall watershed protection program.

EPA's management measures for marinas and recreational boating are described in Section 4.

How Management Measures and Practices Work to Prevent Nonpoint Source Pollution

Nonpoint source pollution control management measures and practices are devised to prevent and reduce the introduction of pollutants generated by marina-related activities to the marina basin. Controlling the entry of pollutants into the marina basin helps protect water quality, control aquatic weeds, reduce odors that result from decaying matter, ensure a more attractive and healthier shoreline, maintain water clarity, and allow for the natural ecological processes of the marina basin and surrounding waters to maintain the basin without the need for expensive chemical or mechanical treatments.

Management measures are recommended to control the delivery of nonpoint source pollutants to receiving waters by

- Minimizing pollutants released to the environment during an activity (pollution prevention).

- Preventing the transport and delivery of pollutants by reducing runoff and thus the amount of pollutant transported (source reduction).

- Treating runoff pollution before it is released into surface or ground waters (source reduction).

Management practices are used to control pollutants generated by specific activities. For example, pumpouts, dump stations, and/or restrooms are installed to discourage dumping sewage into waterways and thus to reduce the release of organic materials and pathogens into the water.

Implementing management measures and practices also provides secondary benefits. For example, use of a vacuum-based (often referred to as "dustless") sanding system prevents paint, wood, and fiberglass dust from being blown about and potentially ending up in marina basin waters. It also improves working conditions for and the health of employees and reduces post-sanding clean-up work so workers can be more productive. Another example of a management practice that provides environmental benefits beyond those linked to water quality is a grassed drainage swale surrounding a marina basin. As a runoff pollution control practice, it reduces nutrient and sediment delivery to the basin. It also provides an aesthetic buffer along the water's edge and natural habitat for aquatic plants and animals.

Nitrogen and phosphorus, in both dissolved organic and inorganic forms, are the two principal nutrients that promote plant and algal growth. In general, nitrogen is the limiting nutrient for plant growth (i.e., the nutrient whose abundance determines rates of plant growth) in marine ecosystems, and phosphorus is the limiting nutrient in freshwater ecosystems. Both nitrogen and phosphorus can limit plant growth in some estuarine systems, where freshwater and marine ecosystems converge, and both are necessary for the production of phytoplankton, free-floating microscopic algae, and macrophytes—larger floating and rooted plants. When the limiting nutrient is overabundant, phytoplankton, algae, and macrophytes can grow excessively, causing a decrease in water clarity, production of surface scum, and clogged waterways. All of these conditions are detrimental to marina operations for aesthetic reasons, such as reduced water clarity and unsightly surface scum, and operational reasons, such as excessive macrophytes that could hinder boat passage and entangle propellers and pipelines. As these plants die, their decomposition in the marina basin consumes dissolved oxygen and degrades water quality. In extreme cases, anaerobic, foul-smelling water might result.

For these reasons, controlling the entry of nutrients into the marina basin makes good managerial sense. The marina will be aesthetically more appealing and operationally more functional, and maintenance costs will be kept down by not having to harvest overgrowths of aquatic plants.

Sources of nitrogen and phosphorus at a marina include detergents that contain phosphorus, sewage from boat heads or on-site septic systems, fertilizers used on marina grounds, and waste from fish cleaning.

The introduction of pathogens into a marina basin due to inadequate sanitation practices is a legitimate cause for concern by marina managers. If the water in a marina basin has an elevated concentration of levels of fecal coliform or is contaminated with viruses, marina patrons could be in danger of contracting illness. Insistence that marina patrons use pumpout stations or have a properly operating Type I or II marine sanitation device (MSD) on their vessel can protect marina patrons from the dangers of poor sanitation and the marina owner from law suits that could result from such incidents. The types of MSDs are described in Figure 3.1. Recreational boats with MSDs are required to have their Y-valves shut to control direct discharge of sewage into surface waters surrounding the marina. Y-valves should also be shut on vessels operated within 3 miles of the U.S. coast.

Untreated sewage, pet waste, discarded fish parts, and all forms of litter can add polluting organic matter and debris to a marina basin's water, creating an aesthetically and biologically undesirable environment. Excessive organic matter in a marina basin leads to lowered dissolved oxygen levels. It also makes water

MSD TYPES

Type I (Vessel size = <65 ft)	A flow-through type MSD where sewage is filtered though an on-board treatment system and then directly discharged. Required to produce an effluent with a fecal coliform bacteria count $\leq$ 1,000/100 ml and no visible floating solids. Rely on maceration and disinfection for treatment of sanitary waste.
Type II (Vessel size = >65 ft)	A flow-through type device larger than a Type I MSD. Required to produce an effluent with a fecal coliform bacteria count $\leq$ 200/100 ml and suspended solids $\leq$ 150 mg/L. A Type II MSD provides more advanced treatment than a Type I MSD.
Type III (All vessel sizes)	Designed to prevent overboard discharge of treated or untreated sewage. Commonly called holding tanks because the sewage flushed from the marine head is deposited into a tank containing deodorizers and other non-treatment chemicals. Contents of the holding tank are stored until properly disposed of at a shoreside pumpout facility. Can be equipped with a discharge option, called a Y-valve, that allows the boater to direct the discharge from the head either into the holding tank or directly overboard. Overboard discharge is illegal in U.S. navigable waters.

Figure 3.1. Marine sanitation device descriptions.

murky. Water clarity is reduced further from other activities that stir sediment and particles of decomposing organic debris up from the bottom. Litter like paper and styrofoam cups, plastic bags and soda can holders, fishing lines or nets, and discarded materials from boat maintenance activities creates an unsightly marina basin. It is also a threat to fish, waterfowl, and shorebirds, which can become entangled in plastics or might eat debris that is mistaken for food and die as a result.

Harmful or toxic compounds in a marina basin create conditions that not only are dangerous to the health of people and animals, but also can be aesthetically unpleasant and expensive to correct. Petroleum compounds can be toxic to aquatic habitat and a nuisance for marina patrons. Oil, gasoline, and materials that contain these compounds (such as discarded oily rags, bilge pads, and dirty bilge water) are pollutants that detract from the beauty of the marina setting with the unsightly surface sheen they leave. In addition, the discharge of any petroleum product in a sufficient quantity to cause a surface sheen is a violation of federal law and is punishable by the imposition of substantial fines and penalties. These compounds foul boats, docks, and anything else that comes into contact with them. Fish gills and the feathers of waterfowl are fouled by these substances, jeopardizing the animal's health, and plant leaves can become coated, preventing or reducing their ability to photosynthesize.

All of these potential sources of pollution to marina basins and the undesirable conditions that they cause for marina patrons and owners point out the importance of establishing controls on how wastes are disposed of, the use of pumpouts, where storm water drains to, and where boat maintenance is allowed to occur. Properly controlled, there is no reason why marina basin waters shouldn't be as healthy an environment for people, fish, aquatic plants, other aquatic organisms as any other part of a waterbody.

Management Practice Systems

Water quality problems can't usually be solved with one management practice because single practices can't provide the full range and extent of control needed to limit the entry of pollutants from numerous sources. Multiple management measures or practices can be combined to build *management practice systems* that address pollutant control needs associated with pollutant generation from more than one source. For example, controlling petroleum hydrocarbon pollution is an objective of four marina management measures (storm water runoff, fueling station design, liquid material, and petroleum control). A single management practice cannot adequately control petroleum hydrocarbon pollution because one management practice can usually address pollution from only a single source. Separate management practices are necessary to control pollution from other sources. For instance, a grassed drainage swale can control petroleum hydrocarbon pollution from surface runoff, air/fuel separators can control it from boat fuel tanks, berms are helpful (and might be required) at liquid material storage areas, and bilge pads are effective in boat bilges. If any one of these sources is overlooked or inadequately addressed, the overall goal of controlling petroleum hydrocarbon pollution in the marina basin might not be attained.

Site-Specific Design of Management Practices

There is no single, *ideal* management practice for controlling a pollutant or class of pollutants in all situations. Rather, management practices should be chosen and designed based on the types of pollutants causing problems, sources of the pollutants, causes of pollution at the marina, climate, type of waterbody, existing water quality, habitats in and around the marina basin, pollution reduction goals, experience of the system designers, and willingness and ability of the marina owner to implement and maintain the practices. The relative importance of these and other factors varies depending on other considerations such as whether the implementation is voluntary or mandatory (e.g., required under a storm water permit).

Important Characteristics of Marina Environments from a Pollution Perspective

Marinas are located on nearly every type of surface water—lakes, rivers, inland waterways, reservoirs, embayments, bays, coastal channels, etc. Each of these waterbody types has different characteristics that affects how pollutants behave in them, that is, whether they are diluted quickly or not, accumulate in sediments or remain in the water column, or concentrate in specific areas or disperse. While marina operators cannot affect the qualities of or processes that occur in waterbodies, knowledge of the qualities and processes particular to the type of waterbody where a marina is located is useful when devising a pollution control strategy and in general for helping understand the larger watershed context within which every marina is located.

General Factors Common to All Waterbodies

Sediment has the potential to be a concern at any marina because of the turbid waters it can create, the dredging that might become necessary if too much sediment accumulates in the marina basin, and the pollutants it can carry with it. Sediment can enter a marina from upland flow (storm water runoff) and from surrounding waters. The amount of sediment contained in either of these sources is very site-specific and needs to be assessed individually at each marina.

Along with the sediment are nutrients and toxic substances attached to sediment particles. The types and quantities of these pollutants are other factors that are best assessed on a site-specific basis. Many chemicals (including nutrients and chemical pollutants) have different forms with different tendencies to attach to particles, biodegrade, and volatilize. Each chemical form might have a different toxicity to aquatic life. The chemical form can change when the compound moves from one environment to another, for instance from ground water to surface water or from freshwater to saltwater. Heavy metals are naturally particle reactive and sorb onto suspended particulates. This process is particularly accentuated in estuaries, where the mixing of fresh and salt water creates turbulent and turbid conditions. Most metals that are transported down rivers to estuaries are removed to bottom sediments in the estuary.

Pollutant resuspension is another potential concern in marinas, and it is affected by currents, boat traffic, and dredging. Toxic metals and hydrocarbons are often mentioned in the context of pollutant resuspension, but bacteria and viruses, nutrients, organic matter, and any other pollutants concentrated in sediments are also resuspended by water turbulence and can cause water quality problems.

The type of waterbody on which a marina is located plays a role in processes in the marina basin, like sedimentation; pollutant delivery, settling, and resuspension; and circulation. The subsections that follow discuss the general types of environments where marinas are located and factors of concern in each of them.

Lakes and Reservoirs

Lakes and reservoirs are strongly affected by the characteristics of the watersheds in which they are located, more so than coastal waters because lakes and reservoirs are not flushed and mixed with a larger body of water. Water that enters lakes and reservoirs carries with it nutrients, sediment, oxygen, decomposing organic matter, fertilizers and pesticides used on farms and lawns, and weathered minerals. In addition, pollutants from onsite waste disposal systems (septic tanks) that leak into ground water, industrial and municipal point sources that discharge into rivers and streams that then feed into the lake or reservoir, street runoff, and pollutants from the atmosphere all enter lakes and reservoirs and affect their ecology.

The water quality and biological effects of pollutants discharged into the waters of lakes and reservoirs depend on a combination of lake and reservoir characteristics.

Depth is one of the characteristics that determines the effect of marinas and recreational boating in a lake or reservoir. Lakes and deeper reservoirs are usually thermally divided during the summer into distinct upper *(epilimnion)* and lower *(hypolimnion)* portions. Because the density of water depends on its temperature, the temperature difference between the upper and lower portions creates a difference in density as well. Wind circulation alone is not enough to overcome the density difference between the upper and lower portions, so there is little exchange of dissolved oxygen between the upper portion and the lower portion while a lake or reservoir is divided in this manner.

The epilimnion usually has a depth of from approximately 10 feet in shallow lakes to 40 feet in deep lakes. A narrow region where water temperature changes rapidly with depth (usually about 1.5°F per 3 feet of depth), the *thermocline*, rests between the epilimnion and the hypolimnion. The hypolimnion is more or less uniform in temperature and extends from the base of the thermocline to the bottom of the lake or reservoir.

Stratified lakes and reservoirs have two periods of overturn or mixing each year, one in the autumn and another in the spring. The change of season from a warm summer to a cold winter destratifies lakes and reservoirs and induces mixing; the reverse process of warming with the change from winter to summer induces another mixing period. Since there is limited exchange of dissolved oxygen between the epilimnion and the hypolimnion while a lake or reservoir is stratified, the oxygen depleted in the hypolimnion during the summer is not replenished until the autumn overturn. During the overturn, when a lake or reservoir is unstratified, dissolved oxygen is usually uniformly distributed from the surface to the bottom.

Stratification and mixing of lakes and reservoirs influence the effect of pollutants on them. When a lake or reservoir is stratified, the upper *(epilimnetic)* volume of the lake or reservoir determines the volume of water available for dilution of fuel, oil, and other wastes that are not mixed into or do not sink into the hypolimnion while the waterbody is stratified. The total volume of the lake or reservoir determines the volume of water available to dilute pollutants over time.

Another important characteristic of lakes and reservoirs is the hydraulic residence time (HRT). The HRT of a lake or reservoir is the time it would theoretically take for all of the water in the lake or reservoir to be replaced by new water entering it naturally. For example, if a lake has a volume of 5 million gallons and natural flow into the lake from streams averages 10,000 gallons per day, the HRT of the lake would be 500 days (i.e., 5,000,000/10,000). In a lake with an HRT of 10 years, therefore, even if pollution input were completely stopped, existing lake water would predominate for many years while new water slowly replaced the polluted water. There would be a long lag time (perhaps 2 to 3 years) before improvements in lake water quality would be seen.

Rivers

Water quality at any point along a river is strongly influenced by upstream water and land uses. If the conditions that affect upstream water quality change, downstream water quality will be affected. Examples of upstream changes in conditions might be land near the river cleared for construction or forest harvesting, which might increase sediment loading, or a land use change from forest to agriculture, which could increase sediment, nutrient, and chemical pollution. Water quality changes at downstream locations can occur in pulses if inputs of pollutants from upstream dredging or pesticide and fertilizer applications, for instance, are shortlived. The duration of changes in water quality depend on the type of upstream change. A change in land use from forest to agriculture over a large area, for instance, could cause long-term changes in water quality, while an increase in suspended sediment from dredging might last no longer than the duration of the dredging work.

Estuaries

Estuaries are similar to coastal embayments with the special characteristic of receiving freshwater from upland areas via rivers and streams. This characteristic creates special circumstances and properties. Where freshwater meets saltwater, there is a change in salinity and alkalinity, a change in water density (since saltwater is more dense than freshwater), a loss of water velocity, and turbulence due to the meeting of fast-moving river water and quiescent estuarine water. These factors affect the behavior of sediment and the pollutants attached to it.

Sedimentation is greater in the upper portions of estuaries where rivers enter because of the water's loss of velocity. Sedimentation also occurs where the freshwater and saltwater meet because the change in salinity causes suspended particles to join together into larger particles and settle. The changes in salinity and pH affect many pollutants, such as nutrients and toxic metals, in the incoming freshwater as well. The form of a pollutant might change because of these changes in the water, making it less or more toxic or causing it to attach to or detach from sediment particles. As in coastal embayments, the force of tides influences estuarine environments as well.

Coastal Environments

Coastal environments are areas of high energy, with tides moving in and out, coastal storms, waves constantly washing against the shore, and currents moving along the coast. Since marinas cannot afford to be subject to all of this energy because of the need to offer protection for boats and on-land structures, they are usually located on quieter embayments along the coast or are protected from coastal energies by artificial means like breakwaters. However, the energetic processes of the coast still exert a strong effect on the water quality and aquatic environment of marinas.

Coastal embayments have quieter waters than open coastal areas, and sediments tend to accumulate in quiet-water areas due to the lack of water movement that permits the sediment to settle. Countering this tendency are tides and coastal storms that mix sediments from the bottom and transport them to open waters. So, in marinas located in coastal embayments, pollutants can build up if tidal action is not strong or the embayment is well-protected from storm action. As noted above, metals transported down rivers to estuaries sorb onto particulates and settle to sediments. In general, more than 90 percent of particulate matter transported by rivers settles in estuarine and coastal marine areas and does not escape to offshore waters.

Modification of coastal areas—for example, by excavating coastal land to create a marina or by adding breakwaters—can alter coastal currents near marina entrances. The effect in any particular area depends on local conditions relating to currents and the sizes and types of sediments transported by them. Coastal currents carry sediments with them, and these sediments tend to be transported into channels that lie perpendicular to the current. Artificial structures and channels can also alter erosion patterns due to alterations of wave patterns in the immediate vicinity. Thus, marinas in altered coastal environments might have to contend with problems of sedimentation and erosion that were not present before the coastal alterations.

Boating on Inland Waters

A picture of marinas and recreational boating on large inland reservoirs, lakes, and rivers would look very similar to a picture of coastal marinas and boating. Lakes and reservoirs range in size from small (an acre or less) to very large. Reservoirs operated by the Tennessee Valley Authority range in surface area size from relatively small (10 to 12 miles long by ½ mile wide) to large (180 miles long by 1 mile wide), and their depths typically range from 100 to 300 feet. The size of a lake or reservoir dictates the types of boats that can be used on it, and the boats used on large inland lakes and reservoirs are usually of the same types (keeled sailboats, large motorboats, and yachts) as those used along the coast. Marinas on large lakes and reservoirs are also very similar to coastal marinas. They can have as many as 200 slips (some marinas on Lake Winnipesaukee, New Hampshire, have 150 to 200 slips); they often have fueling stations, pumpout services, and hull maintenance areas; and boat use is concentrated on the weekends, with holiday weekends being especially busy. Inland marinas can also be smaller, especially those located on smaller lakes and rivers. A directory of marinas in Louisiana lists 51 marinas on freshwater lakes, rivers, and bayous with capacities of as few as 10 boats in slips and/or moorings.

Because reservoirs are dendritic (that is, they have a branching configuration—see Figure 3.2), the surface area in their main channels is limited. Marinas or docks extending into the main channel of a reservoir would impede navigation, and therefore they are typically located to the side of the main channel. Some typical features of lakes and reservoirs are summarized in Figure 3.2.

Boating Access

In 1984, Congress created the Aquatic Resources Trust Fund, which made two sources of funding available for the acquisition, design, and construction of recreational boating facilities. The Boating Safety Account is administered by the U.S. Coast Guard and primarily provides grants to states to help finance boating safety programs, one element of which is access. The Sport Fish Restoration Account is administered by the U.S. Fish and Wildlife Service. Ten percent of revenues to the account from recreational user taxes and a marine fuel tax must be expended by states for boating access. States can also use funds from the account to operate and maintain recreational boating facilities.

The States Organization for Boating Access (SOBA) was created in 1987 to promote the acquisition, development, and administration of recreational boating facilities. The organization maintains close ties with the Coast Guard and Fish and Wildlife Service both to ensure that the

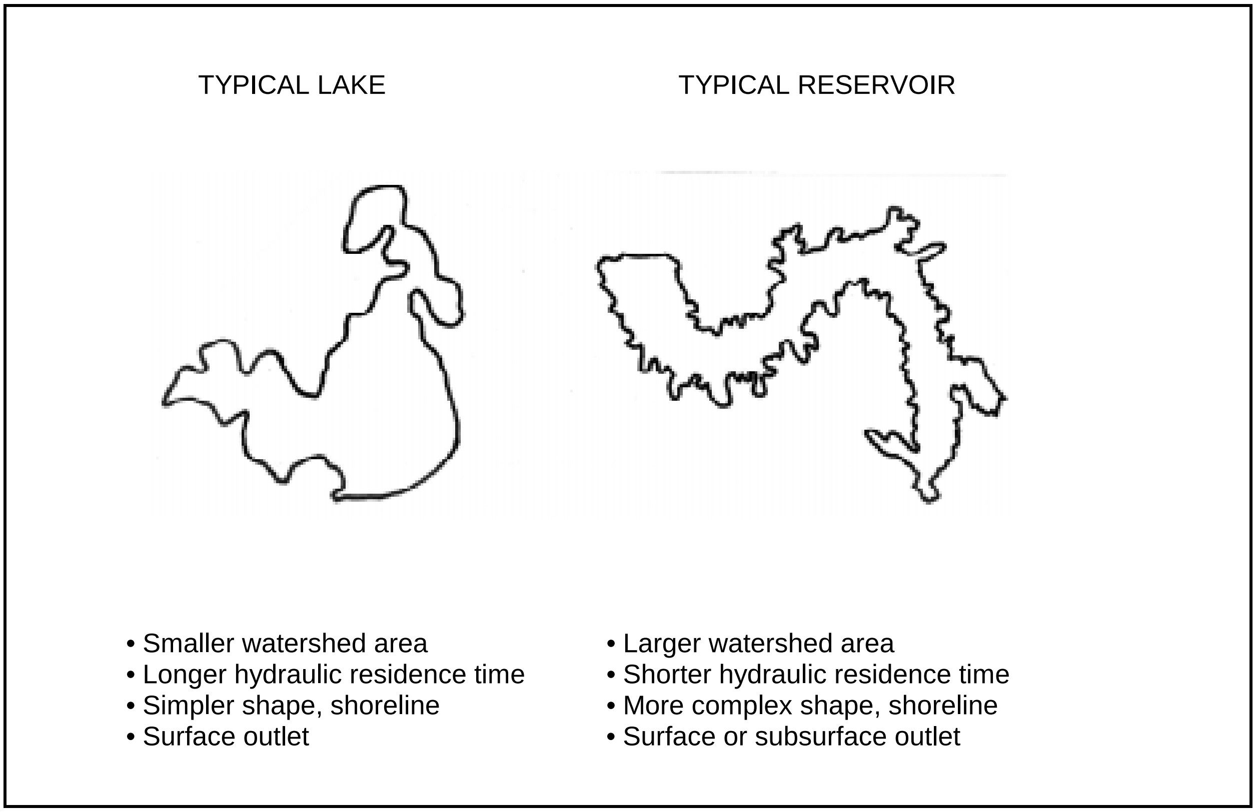

Figure 3.2. Typical features of and differences between lakes and reservoirs.

boating access aspects of the grant programs administered by these agencies receive the funds and attention that Congress intended and to provide input from states on program requirements.

Construction of boat ramps is an aspect of boating access that can affect shorelines and water quality in inland waters. Where appropriate, measures that can help protect the environment and ensure attractive and safe boating access points are highlighted throughout this document and are based on the concepts developed by SOBA. A thorough treatment of the topic can be found in SOBA's book, *Design Handbook for Recreational Boating and Fishing Facilities* (1996), available from SOBA at 919-781-0239.